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PROGRAM INSTRUCTION, LEARNING, AND COLLEGE TEACHING.

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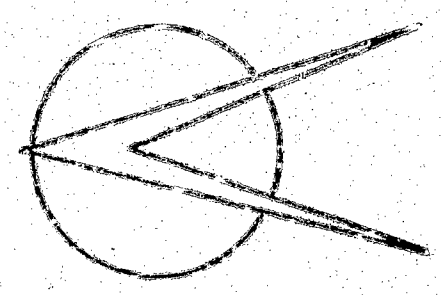
DESCRIPTORS- *JUNIOR COLLEGES, *HIGHER EDUCATION, PROGRAMED INSTRUCTION, LINEAR PROGRAMING, PROGRAM DESIGN, PROGRAM EVALUATION, PROGRAM PLANNING,

A PROGRAM IS A SET OF ITEMS OR STIMULUS UNITS ORGANIZED TO GUIDE OBJECTIVES. LIFE ANY OTHER TEACHING, IT SHOULD BE CHARACTERIZED BY OBJECTIVES STATED IN BEHAVIORAL TERMS, APPROPRIATELY PRESENTED CONTENT, AND CRITERION TESTS OF ATTAINMENT. IT DIFFERS FROM TRADITIONAL TEACHING BY BEING LESS FLEXIBLE BUT MORE PRECISE, ORIENTED TO CONTENT RATHER THAN PROCESS, MORE DEMANDING OF THE STUDENTS' INTERACTION, AND SUBJECT TO MORE RIGOROUS EVALUATION. SUGGESTED STAGES IN PROGRAM PREPARATION ARE (1) FORMULATION OF EDUCATIONAL OBJECTIVES IN TERMS OF OBSERVABLE STUDENT PERFORMANCE, (2) PROVISION OF MEANS FOR ASSESSING PROGRESS TOWARD THE OBJECTIVES, (3) SELECTING CONTENT AND CONSTRUCTING ITEMS APPROPRIATE TO THE OBJECTIVES, (4) ARRANGEMENT OF ITEMS IN A PSYCHOLOGICAL SEQUENCE, (5) TESTING OF THE EMERGING PROGRAM, AND (6) FURTHER TRYOUT, EVALUATION, REVISION, AND FIELD TESTING. A STUDY SPONSORED BY THE GREAT LAKES COLLEGE ASSOCIATION RESULTED IN DEVELOPMENT OF SEVERAL PROGRAMS BY COLLEGE TEACHERS, WHO FELT THAT THE PROCESS HAD BEEN HELPFUL IN IMPROVING THEIR TEACHING. TESTS IN FIVE SUBJECTS FIELDS SHOWED THE PROGRAM TO BE AT LEAST AS EFFECTIVE AS TRADITIONAL METHODS. (WO)



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Robert F. DeHaan, Director
Great Lakes Colleges Association
Programed Instruction Project

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HOPE COLLEGE
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The Use and Development of Programed Materials and Media in Private Liberal Arts Colleges

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INTRODUCTION

Faculties in the Great Lakes Colleges Association rightly pride themselves on great teaching, intense concern for the student as a person, and depth of scholarship. What contribution then could so frankly empirical and pedagogical a project as the Programed Instruction Project make to teaching and learning in such colleges? Do programs teach at the college level? If so, under what conditions? Are programs as effective as time-honored methods now in use? Do programers become better teachers?

This report was written to answer these questions. The project allows us to see possibilities and potentials that lie beyond some of our present understandings and practices of teaching—possibilities that any teacher who is seriously bent on self-improvement will find both intriguing and exciting.

One outstanding feature of the project was the widespread participation of faculty members and administrators in the Association. All twelve colleges participated in the project. An estimated 200 faculty members (about fifteen percent of the total GLCA faculties) were directly involved in the project through conferences, preparing programed materials, field testing and evaluation programs, or through contacts with the director. All faculty members were alerted in varying degrees to new media of instruction.

A second outstanding feature was the intensity with which a number of persons participated in the project. The Liaison Committee[2] actively advised the director and formulated policies under which the project was administered. In addition, 42 programers prepared materials after receiving intensive training in the principles and procedures of programing. Five of them received further concentrated training, and became consultants and editors for other programers. More than two dozen faculty members participated in the evaluation of GLCA programed materials and were given brief but intensive instruction in procedures of conducting research.

A team effort characterized the Programed Instruction Project, carrying it forward from conception to conclusion. A conference of representatives from the colleges created the project. Colleges contributed both human resources and facilities to the project. From faculty members and administrators came ideas that significantly enriched its ends and means.

The Programed Instruction Project was the first GLCA association-wide project. It originated in an authorization of the Board of Directors in January, 1962, which approved the formulation of a proposal for a project to produce and evaluate programed instructional materials at the college level. A conference was called in March, 1962, where the potential of programed instruction for college teaching was discussed with particular reference to experiences already gained at Antioch, Earlham, and Oberlin

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1 A complete technical report of the project can be found in each GLCA college library. See Appendix A for the names of the colleges.

2 Names of members of the Liaison Committee are found in Appendix A.

Colleges. The conference produced a series of agreements about the nature of the prosposed project and the first draft of a proposal was authorized by the Board. Dr. Daniel Smith of Earlham College, with some assistance of other conferees, assumed responsibility of formulating the final draft of the proposal.

The GLCA Research Committee, consisting of Chairman Samuel Baskin, Antioch College; Paul Carnell, Albion College; Robert De Haan, Hope College; and Celeste McCullough, Oberlin College, submitted the proposal to the U.S. Office of Education in March, 1963. The Office of Education accepted the proposal for support and funded it in the summer of 1963 under Public Act 85-864 Title VII, Part B, Dissemination Activities Concerned with the More Effective Utilization of Media for Educational Purposes. The original contract began on June 27, 1963, and ran through June 27, 1965. The contract was extended to June 30, 1966.

PURPOSES OF THE PROJECT

The purposes of the project were five:

1. To develop programed instructional materials for college level teaching.
2. To evaluate existing commercial programed materials.
3. To evaluate and compare uses of programed instructional materials and thereby to discover where they fit into the curriculum.
4. To promote basic research and instruction and to evaluate the broader effects of programed instruction.
5. To disseminate the results of the project.

WHAT IS PROGRAMED INSTRUCTION?

A program is a set of items[3] selected and ordered in such a way that a student, working through the set, can gain optimal attainment of the stated objectives. A program is relatively self-instructional; it constantly calls upon the student to respond. Programed instruction has more to do with the *method* than with the *content* of teaching.

There are no *a priori* rules governing the format of the program or the medium of presentation. Items may conceivably be as small as a word or large as a page. They may be written, tape recorded, or sketched by an artist. They may be printed and bound together in book form, typed on 3 x 5 cards and packed into recipe boxes, or adapted for computer assisted instruction.

A program is probably the most sophisticated attempt to date to bring together three essentials of good instruction: *Objectives* stated in terms of observable student performance; *content* presented in such a way that the student by working through it achieves the objectives; and *criterion tests* which ascertain the extent to which the student actually attained the objectives.

Below is an example taken from a program that was prepared on the Programed Instruction Project. The objectives are given first and are expressed in terms of observable student performances. The objectives communicate to the student what he can expect to learn from using the program.

POETRY, METHOD AND MEANING: A PROGRAM IN POETIC ANALYSIS AND CRITICISM

James W. Cook, Department of English,
Albion College, Albion, Michigan

General Objectives:

1. Student should use critical vocabulary when writing, thinking, or talking about poetry.
2. Student should identify figures of speech and thought when they occur in a poem.
3. Student should be able to analyze and specify the contribution of figures of speech and thought to a poem's meaning.
4. Student should be able to posit multi-level interpretations of a poem.

Courses for Which Intended:

Introduction to Literature or any course in which poetry, especially lyric poetry, is to be a primary concern.

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3 An item is a variable amount of material which serves as a stimulus unit to which the student is asked to respond. An item is sometimes called a "frame" because in some early programs it was presented as a frame in a teaching machine.

Topics Covered:

Basic poetic figures of speech and thought and the concepts of metaphor, symbol, and image as they interact and contribute to the meaning of a total poem.

Approximate Time Required:

Four to eight hours.

Prerequisite Knowledge:

Freshman or sophomore college standing or advanced high school student without previous experience.

Here is a sample page from a later section of the same program. Note how item 51 begins to help the student attain the second objective of the program—to identify figures of speech and thought—although the student must go much further in the program before he will attain the objective fully.

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51. Images constitute another very important class of figures of speech. One might say that an image results when a passage is so vividly descriptive that the reader *imagines* a sensory experience. For example: "The smooth and creamy vanilla ice cream, cool upon my tongue, melted gently toward my tonsils." Now, while you really can't *taste* the ice cream nor *feel* its texture or its temperature, you can *imagine* that taste and that feeling.

Try it! Got it? Yum!

Thus, an image is a figure of speech that represents a concrete experience or an object by appealing to the senses through the _____. imagination

A poet may appeal to sight, hearing, smell, taste, touch, the senses which distinguish changes in temperature, which register balance and motion, and which register visceral reactions. For our purposes, include the last three under touch.

Below is page 37 from the same program. By referring again to the objectives of the program, the reader can see that items 52 and 53 are meant to further the student's achievement of the second objective.

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52. Which of the following quotations contain images? Circle the appropriate letters.

A. All in a hot and copper sky
The bloody sun at noon
Right up above the mast did stand
No bigger than the moon.

B. Grow old along with me.
The best is yet to be.

C. I cannot see what flowers are at my feet,
Nor what soft incense hangs upon the boughs,
But, in embalmed darkness, guess each sweet
Wherewith the seasonable month endows
The grass, the thicket, and the fruit tree wild;
White hawthorn and the pastoral eglantine,
Fast fading violets cover'd up in leaves
And mid-May's eldest child,
The coming musk-rose, full of dewy wine,
The murmurous haunt of flies on summer eves.

You should have circled A and C.

Observe that the *tied* images in A and C are such that they evoke virtually the same imaginative responses in most readers. Look back at A and C and analyze your responses. To which senses do the *tied* images in A and C appeal? (They may appeal to more than one.) List them. Which words seem to control that appeal?

53. *Senses* *Words*

_____ _____
_____ _____
_____ _____
_____ _____

What follows below is an example of some criterion test questions designed to ascertain the extent to which the student has attained the first two objectives of the program. The test can be used as a pre-test to determine how much the student already knows of what the program can teach. The instructor has the option of excusing the student from those parts of the program that he already knows. Or the test can be used as a final test of achievement.

Pre- or Post-Test
(Form 1)

I. In your own words, define and give two or three examples of literary convention.

Image and Symbol

1. In your own words, state your concept of an image.
2. What is a tied image?
3. What is a free image?
4. What is a synaesthetic image?

II. The following list contains the names of figures of speech often employed by poets:

1. Metaphor
2. Simile
3. Personification
4. Apostrophe
5. Hyperbole
6. Synechdoche
7. Conceit
8. Metonymy

The passages which follow contain one or more examples of each of these figures. By placing the number before the appropriate letter, match the name of the figure with the underlined example.

_____A. Love bade me welcome; yet my soul drew back
Guilty of dust and sin,

_____B. But quick-eyed Love, observing me grow slack
_____C. From my first entrance in,
_____D. Drew nearer to me, sweetly questioning
_____E. If I lacked anything.
_____F. My Shakespeare, rise; I will not lodge thee by Chaucer or Spenser, or bid Beaumont lie a little further to make thee a room;
_____G. thou art a monument without a tomb . . . . .

Programs and Traditional Teaching Media

Programed instruction is similar at some points to *expository* teaching and at other points to *extemporaneous*[4] teaching, as found in some classrooms and in discussion groups. Both programed instruction and expository lectures are pre-designed, both can be planned deliberately before they are used. But there are also differences. A lecturer places greater emphasis on the content of a lecture and relatively less emphasis on his objectives or on assessing the students' attainment of objectives than does a program writer. In an expository lecture the lecturer tends to assume that what is taught is learned. On the whole, a lecture tends to be a more flexible teaching instrument than is programed instruction, but by the same token tends also to be less precise.

In extemporaneously designed learning the conditions of learning are created on the spot as instruction proceeds. The emphasis is on the *process* of interaction, not on precisely *what* is learned, as is true of programed instruction. That is, the outcomes of learning are less focal than the process. Although discussion is a highly flexible instructional instrument, its outcomes are hard to evaluate. In common with programed instruction, however, extemporaneous teaching emphasizes the importance of the learner's activity. Discussion seems to lead the learner toward rather different objectives from those typically found in programed instruction.

A textbook is designed largely as a reference work. It is logically organized. Content is emphasized. Practically the only way students can interact with the material beyond simply reading it is to underline parts of it.

A program is designed as an instructional device engaging the student in a dialogue, which although perhaps crude, is analogous to a tutorial relationship. The requirements for the student's interaction are more intense than for a textbook.

The feeling of frustration expressed by some students who used programed materials may have come from their reading the program like a textbook instead of interacting with it. Learning by means of a program takes the same kind of concentration that taking a standardized test requires.

Origins of Programing

Although the beginnings of programed instruction can be traced to the decade of the twenties and the teaching machines of Sidney Pressey, general

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4 Robert Gagne, *The Conditions of Teaching*, New York: Holt, Rinehart Winston, 1965, pp. 250-251.

interest in programed instruction did not crystalize until the middle fifties when Professor B. F. Skinner, drawing upon the results of experiments in animal learning, devised programs using "operant conditioning," a term which has been used to describe his model of learning. This model emphasizes the following principles of learning which were applied to programing in its early stages: The necessity of a student's actively responding (emitting behavior to be "shaped"), presenting the material to be learned in small steps, immediately reinforcing correct responses, reducing the number of errors a student made in learning the material, and allowing the student to proceed through the program at his own rate.

The Programed Instruction Project, however, took a new look at programed instruction. Programers discovered not only that new programs can be made more sophisticated than many of the early ones, but also that programs based on a problem-solving or discrimination model of human thinking are more suitable for college students than those that draw their major principles from animal learning. The new species of programs require the student to discriminate among perceptual and cognitive stimuli and do not require immediate reinforcement of his responses. The new problem solving programs grow out of information and cognitive theory rather than operant conditioning. Programs based on the operant conditioning model, on the other hand, were designed to lead the student to the solution or the principle without his necessarily being consciously aware of arriving there.

According to this new concept of programing the task of the programer is to establish conditions in which concepts, principles, solutions to problems can be created or discovered by the student from the "raw materials" of data, information, problems presented to him in the items of the program. Inductive problem solving, the mode of the new programing, provides the necessary raw material and a minimum of clues to help the student, but allows him to discover his own generalizations and conclusions.

PREPARING PROGRAMED INSTRUCTIONAL MATERIALS

The preparation of problem-solving programed instructional materials casts new light upon the process of instruction. Programing exposes for examination many aspects of learning and teaching to which the programer may have previously been indifferent or blind—especially behavioral objectives, strategies of learning, evaluation of outcomes. For example, the process of writing the first item of a program brings into focus the learning problems that students face in adopting the frame of reference required by the instructor. Until one writes a program he may easily shift the responsibility of this requirement to the student. By committing his instruction to a program, the programer can more easily see his own responsibility to adapt his teaching to the learner's frame of reference.

Preparing a program is akin to making a slow motion film of a baseball pitcher's delivery. Learning processes that usually occur swiftly, to be lost forever, are captured in the process of programing. A teacher, under ordinary classroom conditions, may explain a point and hurry on, failing to see the momentary blank look of a student. The failure of an explanation can be seen in a program, however, when students stumble again and again over a weak item.

It is next to impossible for an instructor to obtain detailed and immediate feedback on the efficacy of other modes of teaching. On the project, however, programers tested their materials regularly with volunteer students as they wrote the programs. Such feedback not only improved the programs but also allowed the programer to observe how hard some students had to struggle to understand ideas which he had written in his most brilliant style. Programing highlights the value of such feedback.

Most importantly, preparing a program forces an instructor to lay out for himself, his colleagues, and his students what he expects students to gain from his program, how he expects them to attain the goals he has established, and what level of student performance he will accept as evidence that the students have attained the goals. Making such a commitment is rare among college teachers.

Below is an outline of steps taken in the process of preparing programed materials.

1 — formulating educational objectives in terms of observable student performance—specifying the outcomes in terms of desired changes to take place in the learner—one of the essential and most illuminating aspects of the process of programing.

2 — making provision for assessing the student's progress toward the objectives. The programer writes examination questions that will assess the student's anticipated progress toward the objectives before he writes the content of the items. Examinations are treated as a derivative of the objectives rather than of the content of the program.

3 — selecting the content of the program in terms of the objectives and constructing items that contain the content. The objectives spell out what changes the instructor desires to see take place in students. Selection of the content and writing the items then follows logically from the objectives.

4 — arranging the items not in logical sequence but in a psychological sequence. A psychological sequence is one in which the pace, the amount of material, the order of presentation fits at least in some crude manner students' styles of thinking and learning. As the programer organizes his materials he does so with the student, as well as his objectives, clearly in mind.

5 — developmental, step-by-step testing of the emerging program. Such testing informs the programer whether or not the material is geared to the student's approach to learning as well as to the objectives which the program is designed to help students attain.

The contents, the sequence, even the test questions and objectives of the program are revised in light of the reaction of the typical test subjects to the tentative sequence of items. If, for example, the objectives of the teaching sequence turn out to be inappropriate for the achievement level of students for whom the materials are designed, the programer adjusts the goals to the level which the student can, in fact, attain.

6 — the rest of the items are drafted, tried out on more students, presented for criticism to colleagues, and revised at every step until the process yields the first version or "field-test" draft of the programed material. It is then tried out with one or more groups of students under conditions approximating those in which it will be used. The field test gives the programer information about problems of administering the program under normal conditions.

The sequence of steps outlined above is not a rigid one. It does communicate, however, the care with which materials are prepared for programed instruction and it does suggest that more care needs to be taken in the preparation of all instructional processes than may have been thought necessary in the past.

Summary

Each step has obvious connections with what an instructor does as lecturer, evaluator, discussion leader, tutor. A person may teach acceptably in traditional fashion for years without ever examining these connections or being squarely confronted with the assumptions he makes about learning and teaching. Writing a program in the manner described above leads a teacher to examine directly some of the most significant aspects of his teaching processes. Preparing programed materials is one of the best ways yet devised for getting an instructor to look at *learning* rather than *teaching*.

The Training Process

Twenty-two faculty members representing all GLCA colleges received grants from the Programed Instruction Project to be trained to prepare programs during the summer of 1964. An additional grant was split among four people who made requests for minor programs and another among

four librarians to produce programs for library personnel. In addition, two persons received half-time grants to produce programed material the following school year.

It is sometimes asserted that the exact sciences can be programed most easily. Faculty members from the Great Lakes colleges, however, discounted that generalization. Instructors from almost every discipline in the liberal arts curriculum were involved in preparing programed materials.

The decision to train GLCA instructors in the principles and techniques of preparing programed materials was a most significant decision. The project was transformed thereby from a mere production-evaluation project to an inservice education project as well.

Staff members of the University of Michigan provided the "new look" in programing and gave competent and insightful training for the GLCA programers during the summer of 1964, on the Dearborn campus. Twenty-two programs were produced and an additional three or four smaller programs were in the making. The programers field tested these programs during the fall of 1964 and revised them on the basis of the results of the field tests. It took approximately two-and-one-half months, including training time, to prepare an average of 10 hours of programed learning material. Procedures for recruitment selection and training of the twelve programers for the summer of 1965 was basically the same as for the first group of programers.

Authors, titles of programs, and general objectives of programs can be found in Appendix B.

EVALUATION OF GLCA-PRODUCED PROGRAMS

Skepticism about the teaching effectiveness of programed instructional materials runs high in most liberal arts colleges. GLCA colleges are no exception. It is a healthy skepticism, and it must be satisfied if pre-designed programed materials are to make any contribution to college teaching.

The evaluation of the GLCA-produced programs was designed to answer questions that were selected for their general interest and pertinence to the interests and concerns of GLCA faculty members about programed instruction. The questions are:

- Do programs teach at all?
- Do programs teach as effectively as textbooks or lectures covering the same material?
- What classroom activities, such as question-and-answer discussions or lectures following students' use of the program, most effectively capitalize on what students have learned in the program?
- Is the program more effective as an instrument for the acquisition of knowledge or as a device for reviewing information acquired earlier by some other means?
- What effect do various motivational devices have on learning by programed materials versus other methods?

Five programs produced by GLCA faculty members during the summer of 1964 were selected for the intensive evaluation. The programs were the following:

POETRY: METHOD AND MEANING, James W. Cook, Department of English, Albion College, Albion, Michigan

LANGUAGE OF LOGIC, Morton Schagrin, Department of History of Sciences, Denison University, Granville, Ohio

BIOCHEMISTRY FOR BIOLOGISTS, William K. Stephenson, Department of Biology, Earlham College, Richmond, Indiana

THE LITERARY RELATIONSHIPS AMONG MATTHEW, MARK, AND LUKE, Robert M. Montgomery, Department of Religion, Ohio Wesleyan University, Delaware, Ohio

AN INTRODUCTION TO SYSTEMATIC ANALYSIS IN POLITICAL SCIENCE, Lois M. Pelekoudas, Department of Political Science, Antioch College, Yellow Springs, Ohio

The programs were selected on the basis of their high quality and because they represented each of the major divisions of the liberal arts curriculum—natural science, social science, and humanities. The programs were short ones, taking 5-12 hours of a student's time spread over a two or three week period.

The evaluation studies were designed in such a way that each of the five programs was evaluated under four different and comparable conditions in an attempt to answer not only the first general question about the ef-

fectiveness of programed instruction, but also to answer the specific questions about the conditions under which programs can best be used. In the first set of studies the program was evaluated against one or more of the traditional methods of college teaching—classroom expository lecture, classroom question and answer period, or the use of a textbook. The second set of studies attempted to discover if a program works better when it is followed by a lecture or by a question and answer period. The third study attempted to discover whether a program is more effective when used as an instrument solely for the acquisition of knowledge or as a device solely for reviewing information acquired by some other means. The fourth study attempted to discover if various forms of motivation affected the students learning through programed materials.

In order to qualify as a program evaluator, an instructor had to be teaching a course for which the program was suitable during the first semester of the 1965-66 school year. He had to have two sections of the course available—one for experimental and one for control purposes. He had to be willing to devote the equivalent of 10 full days to the evaluation process including attendance at a workshop on experimental procedures. He had to be willing to follow the rigidly prescribed experimental procedures including such things as a verbatim prescription on how to introduce the whole procedure to students, exactly how much class time to allow.

A total of twenty-six instructors from eight GLCA colleges, plus one non-GLCA college, participated in the study. Their names are given in Appendix C.

We were concerned not only to measure the amount of learning that occurred by means of achievement tests keyed to the programs, but also to assess students' and instructors' attitudes toward programed materials in comparison with other methods of instruction. Therefore, each participating student and instructor was given an attitude questionnaire on which to express his opinions about various aspects of programing and other methods of instruction. A total of 1220 students from nine colleges and universities participated in the project.

Each study used an experimental and a control group. Students were tested before the experiment to find out how much they knew about subject matter that was covered by the program and again at the end of the experiment, with a different form of the same test, to find out how much knowledge they gained. The same evaluation questionnaire was used by all students; a comparable questionnaire was used by all the evaluators. Most of the evaluation studies were completed in the first semester of the 1965-66 school year. The data was processed and analyzed at the Computer Center of Kalamazoo College in the Spring of 1966.

Results

The data from the evaluation studies substantiate clearly that students do learn from programed materials under a variety of conditions of the experimental designs and as judged by the pre-and-post-test results. A summary of the results is given in Appendix D. Also, students learned as much from programed materials as from other methods of instruction. Students

who used the biochemistry program learned significantly more from the programed material than from either lectures or textbooks covering the same material. Thus, the first two questions raised about programed instruction can be answered affirmatively.

No evidence from the evaluation studies favored either lectures or question and answer discussion periods following the students' use of a program as a means of effectively capitalizing on what students learned in the program. Evidence from the studies indicate that a program can be used as effectively either to introduce a unit of material or to review the material. Whether students volunteered to learn a unit of material by means of a program or whether the material was a required part of the course made no difference in the amount of learning that took place. Thus, no conclusive answers can be given by this research to the last three evaluation questions.

The student attitudes toward programed instruction were more positive than negative. Their attitudes toward programs and other methods of instruction were compared. The order of student preference was lectures the most favored, then programed materials, then question and answer discussions, and finally textbooks. The professors conducting the studies expressed positive attitudes toward programed instruction following their participation.

Summary and Conclusions

The Liaison Committee, with the director, conducted a set of carefully designed and executed evaluation studies on the effectiveness of the programs as teaching devices. Five outstanding GLCA programs were selected for evaluation. Five evaluation questions were raised with respect to the effectiveness of teaching by means of programs. The project designed research to answer each question with respect to each program. Twenty-six instructors were selected to carry out the evaluation. Each one had access to students for experimental and control groups. The project paid and trained instructors to carry out the research under as rigidly defined conditions as possible. Questionnaires were used to gather subjective evaluations of the programs by both students and instructors. The programers, with the consultant help of colleagues, designed pre-and post-tests with which to measure the achievement of students, both in experimental and control groups.

The data were treated by analysis of variance and multi-variate analysis in order to answer the questions posed by the research.

It can be stated with some confidence that college students can learn from programed instruction and that they and professors express favorable attitudes toward it under conditions which prevailed in the evaluation studies. All the programs tested were as good as and one was better than traditional ways of instructing.

The implication is that programed instruction is a legitimate medium for teaching at the college level.

ANALYSIS OF WHY PROGRAMS SUCCEEDED

Few instructors know, with any assurance, why they are successful as teachers, with what kinds of students they are most successful, or under what conditions their students learn best. The multiple correlational analysis of evaluation data of the GLCA-produced programs provided basis for examining answers to such questions. Success, for this analysis, was defined as a high score on the post tests. Nineteen variables were correlated with post test scores. As could be expected, the programs were successful for different reasons. They did not work equally well with all students under all conditions, although they all taught as well or better than other methods of teaching with which they were compared.

Students of high verbal ability (as measured by the College Entrance Examination Board tests), who were under-classmen, who did not spend a great deal of time on the program, were most successful with the *Poetry* program. Those who succeeded on the program tended to rate it as being too easy, but liked it better than textbooks, lectures, and discussions.

Male students having high math scores on the CEEB tests were most successful with the *Logic* program. Such students rated the program as a positive learning experience, were not in doubt about the direction in which the program was moving, and rated the program as stimulating and delightful.

Upperclassmen did best on the *Biochemistry* program. No other variables included in the research, however, accounted for the success of the Biochemistry program.

In the *Religion* program, those who had not used programed materials before did better than those who had. The program also favored the slower student to some extent. They rated the program stimulating, efficient and delightful, indicating further that they were not in doubt about the direction that the program was taking and that the program was easy to review.

Students with high verbal scores on the CEEB were most successful with the *Political Science*. In addition, there was a significantly high correlation between being a female student and succeeding on the program. Spending a good deal of time on the program was also positively correlated with success on the program.

The analysis did not account for all the variables that may have possibly been correlated with success on the program. There are many unknown variables about which this analysis says nothing. At best, only 40 percent of the variance was accounted for on one of the programs; at the other extreme, only about 12 percent of the variance was accounted for on another program. These results are summarized in Appendix E.

It is intriguing to wonder if typical teaching methods, such as lecturing and discussing, also reach only certain students and not others. If an instructor knew what kinds of students he reached under what conditions, might he not vary his methods so as to give more students a chance to succeed?

Summary and Conclusions

Programs succeeded with different kinds of students for varying reasons. Assuming that the programed material an instructor prepares is roughly comparable to his total style of teaching, the above analysis suggests the possibility that preparing one's own programed instruction and assessing what kinds of students succeed in using it provides a procedure whereby an instructor can obtain objective evidence on what kinds of students he reaches under what conditions.

A STUDY OF THE IMPACT OF PROGRAMING ON TEACHING

The GLCA Programed Instruction Project asked more than the production of programs, effective as they might be as teaching devices. The Project sought, in the preparation of such materials, a process that would generate new insights into fundamental dimensions of teaching. If the process of writing programs could be made to illumine the broader domain of teaching, the value of the process would extend into the other teaching procedures used by the programers.

Programers responded to questionnaires that were used to evaluate the two Summer training workshops and the experience of preparing programed materials. Following are answers of the programers to a question which dealt with the general impact of programing. The question is:

— Judging from your experience so far, at what points in your total teaching practice is programing likely to make an impact?

One programer answered as follows:

> I find, I am pleased to say, that I have become deeply interested in the possibilities which programing offers in my field. I have already thought of another subject related to my interests which has not yet been programed. The work this summer, although it has been taxing, has not been a "chore" for me, and I have looked forward to each day's attempt. I had thought that completing a textbook I had planned to write would have been more exciting and more personally rewarding; now I would hesitate to say that. I give most of the credit for this interest to the organization of the first workshop and to the follow-up procedures: visiting editor, outside consultants, provision for test subjects, etc.

A second programer answered in the following manner:

> The experience of programing is going to make my objectives in all my courses much more specific and precise—which is to say that programing is a process that develops a certain kind of critical sense about the teacher's obligation to the student. The experience is going to mean a more critical use of lecture materials, with a clearer distinction between what the student might best learn for himself with suitable guidance and what he can learn best from an organized lecture.

Below is the way another programer evaluated programing:

> This has been very stimulating to me. The developmental testing alone has provided much new "food for thought" on the problems of teaching and learning. The difficulties encountered by the students trying out my program have shown me some large faults in what I had assumed to be acceptable teaching methods. These experiences and the technical information supplied at the two workshops make me feel that I have learned a great deal which will be very useful to me professionally even if I do not develop into a good program writer.

Here is another answer:

> I've been dismayed at how easy it is to beg the question in organizing the presentation of a body of information, and delighted to see how students respond to a mode of analysis that programing demonstrates very effectively. On the one hand, I find it hard to be clear and to arrange for an "organic" development through a batch of material; on the other hand, I'm put off by how slow and repetitious have been the three or four published programs I've worked on. I'm becoming interested especially in the next step after programing—a step toward identifying students' modes of working and then helping them capitalize on their mode as well as practice "alien" modes.

One last example:

> Its strongest impact has been on how I think through a problem and, through that effect, onto my sensitivity to how students may be working on a problem. I'm less eager to "cover" a body of material and more eager to help a student hit his stride in discovering the order and the nature of the material.

On another occasion, programers were sent a follow-up questionnaire asking them to evaluate their experience in preparing programed material as they looked back on it from the vantage point of nine months. The answers were categorized and are reported below.

1. *Programing forces systematic thinking about the teaching process.* One programer said that programing was good for saying exactly what he wanted to say. Another mentioned that programing gave him insight into creating detailed materials. Still another said that he was forced to think more systematically about teaching. Another became thoroughly persuaded that the material he had worked on was programable, whereas previously he had wondered whether it was. Still another reported that he became aware of the necessity of careful planning in all areas of teaching.
2. *Teachers became more aware of the necessity of formulating course objectives.* One person mentioned that programing helped him set up goals for all his teaching; another seemed to become more conscious of course objectives. Still another put it this way, "What can be tested can be programed." Constructing a program gave another programer a clear sense of what he wanted to accomplish.
3. *The value of feedback from students.* The programer suggested the value of thoughtful student evaluation of the materials. Another said, "Field testing showed me the value of detailed feedback from students." Still another said that programing gave him better understanding of how a student's mind works—"I would not have known the difficulties had I not tried to program." Still a fourth programer mentioned that he was prompted to reconsider the contact time that he had with students.
4. *Application of programing principles to other areas of teaching.* A programer reported that he had revised his lab exercises along lines of the linear program. Another mentioned that he had tried out different use of lecture time. A third mentioned that, ". . . . . I am more critical about use of class period and testing procedures."

5. *Insights into the learning-teaching process.* A programer said that he is now more patient with the learning process after having developed a program and tried it out on students. Another indicated that preparing a program had made him aware of how concepts can best be put across. Still another programer mentioned that writing test frames helped him write exam questions which really distinguished students who have attained the objectives from those who have not.

To establish more scientifically the relationship between preparing programed materials on the one hand and other aspects of teaching on the other, a more formal study was designed, using systematically collected data.

An attempt was made to answer the following questions:

1. Does preparing programed materials, as outlined in a previous section, influence the programer's concept of teaching?
2. Is it possible to identify assumptions about selected aspects of teaching which differentiate programers from non-programers?
3. Using the assumptions as criteria, can independent judges reliably differentiate statements about selected aspects of teaching made by programers from statements made by non-programers?
4. Specifically, what assumptions held by programers differentiate them from non-programers and which concepts held by non-programers differentiate them from programers?

Drawing on answers previously given by programers, the director made the following nine assumptions about the impact of programing on the programers' thinking about and attitudes toward teaching.

1. In preparing programed instructional materials the *methods* of instruction acquire more value relative to *content* than is usually ascribed to them by college instructors.
2. Formulating objectives in explicitly behavioral, objective, operational terms (in terms of outcomes of student behaviors) is a cardinal principle of programing.
3. An important principle of programing is that students should be tested in terms of progress in attaining the objectives of the program.
4. Analysis of materials to be programed is related to and grows out of objectives of the program, and material to be programed is to be organized empirically and pragmatically in terms of the students' ability to deal with it.
5. Testing of students' knowledge of the material prior to the students' starting the course and to reorganize the content and methods of the course in the light of what he discovers about students' previous knowledge.
6. Students need to be actively and responsively engaged in learning; their activity improves not only their learning, but also provides feedback to the programer about the strengths and weaknesses of his program.

7. The material itself must be intrinsically motivating, since the programer cannot count mainly on interpersonal relationships with students to motivate them.
8. The purpose of testing students is not only to evaluate the progress of the students toward the objectives of the program, but also to give the teacher data with which to revise his assumptions about students' knowledge, the level of difficulty of the content, and the sequence of the material.
9. After having been trained in programing principles, and having prepared a program, the programer will be (a) more likely to use new instructional media in his teaching, (b) favorably disposed toward their use, (c) know how to use them discriminatingly, and (d) be informed about them.

Twenty-four subjects were interviewed in the study, twelve of whom were 1965 GLCA programers and twelve of whom were the control group, selected by the deans to match each of the programers. The interviewer did not know which interviewee had prepared programed material and which had not. The questions in the interview allowed the respondents to talk about their concepts and practices of teaching in relation to each of the nine assumptions; but they did not know what the assumptions were.

The interviews were tape recorded. In addition, the answers of the respondents were summarized in written form by the interviewer who asked each respondent, at the end of the interview, to go over the written answers to make sure that they contained an accurate statement of his thoughts. The interviewer's answers were typed, coded, and assembled in random order into answer booklets. Each booklet contained all the answers to one question.

The assumptions were stated as criteria so that each judge could rate each answer on the degree to which it expressed the same idea about teaching as did the assumption. Three judges who did not know the programers but were acquainted with the principles and techniques of programing spent two days in training and then independently judged the respondent's answers in terms of how well they fit the assumptions. Each answer was rated on a five point scale from best fit to least good fit.

The rating of each judge of each answer was recorded. The scores were statistically analyzed to ascertain the extent to which the programers', more than the non-programers', thinking about teaching fit the assumptions and also which assumptions most clearly differentiated programers from non-programers. Programers scored significantly higher than non-programers, indicating that their answers conformed more to the assumptions than did those of the non-programers. In addition it was possible to identify three assumptions which most clearly differentiate programers from non-programers.

Programers more than non-programers, believed that:

1. (assumption 9) Having prepared a program, a programer is likely to use new instructional media in his teaching, be favorably disposed to their use, know how to use them discriminatingly, and be informed about them.

2. (assumption 2) In preparing programed instructional materials the *methods* of instruction acquire more value relative to *content* than is usually ascribed to them by college instructors.
3. (assumption 4) Analysis of materials to be programed is related to and grows out of objectives of the program, and material to be programed is to be organized empirically and pragmatically in terms of the students' ability to deal with it.

The other assumptions did not statistically distinguish the programers from the non-programers.

Summary and Conclusions

This pilot study strongly suggests that preparing programed materials changes and expands the programer's concept of teaching. Programing promises to be a significant procedure for analyzing and improving some important aspects of teaching; especially those having to do with newer media, methods and empirically analyzing content. But the door has just been opened. Many large areas of the total teaching-learning process remain to be investigated and developed via the preparation of programed instructional materials.

Further sustained and more rigorously controlled research needs to be conducted to ascertain which aspects of teaching are most influenced by programing and the point at which further programing no longer produces new insights into teaching. What needs to be done to help teachers translate and generalize their new insights into teaching to their actual classroom behavior is still open for further investigation. Such research will help determine the future role of preparing programed instructional materials in the total pre-service in-service education of college teachers.

EVALUATION OF COMMERCIAL PROGRAMS

An original objective of the project was to review and evaluate commercial programs that were available in 1963. On several occasions the project director provided the opportunity for faculty members of GLCA colleges to examine, use, and evaluate commercial programs. For example, early in the project, the director sent out a list of materials that were available in his office to the Liaison persons for distribution to the department chairmen. During the Winter Work Conference of 1964, all available commercial programs were displayed, and in May of 1964, the director displayed them again for a day on each campus.

Faculty members generally paid little attention to the commercial programed materials. Their indifference was not wholly unexpected. By no means were all the available 150 commercial programs of college level quality. Some of the faculty members indicated that the only way they could use the programs that were available in their field would be as remedial programs. The greatest concentration of programs was in the field of mathematics. The sciences were the next best represented of the disciplines. Modern foreign languages were the third. Only a few programs were available to the rest of the disciplines.

By the end of the first year of the project, a total of fourteen faculty members had agreed to evaluate an off-the-shelf program in one of their classes during the 1964-65 school year. Each of the professors who evaluated one of the commercial programs also responded to an evaluation questionnaire. The questions were designed to sample the instructor's attitude about the value of the program as a teaching device.

A tabulation of the questionnaries revealed that two-thirds of the instructors thought the programs actually taught what they were presumably designed to teach. About one-third of the instructors found errors in the content of the program. Two-thirds of the instructors said the program saved them time; one-third were uncertain or said it did not save them time. The same ratio existed in the answer to the question of whether the content covered in the program justified the amount of time required by the student. The programs were considered rather expensive; less than half of the instructors thought the program was justified in terms of the cost. Only half of the instructors had a very positive experience with the commercial programs or expected to use similar material again. The others were divided between feeling somewhat more positive than negative toward the program and feeling more negative than positive.

An analysis of the achievement of the students who used the program revealed no over-all pattern of success or failure of the programs. The success or the failure to teach seemed to be related specifically to each program. Where the program was generally considered to be a good one, the instructors evaluated it positively and students learned from using it; where the program was poor, the results of the evaluation were negative. But no conclusions could be drawn about programs in general.

In addition, the relative lack of control on the evaluation procedures made it difficult to draw any firm generalizations about the value of commercial programs. The results indicated that each instructor who is considering using programed materials needs to try out the program in his own classroom in order to assess its value to him.

CONCLUSIONS

In light of the total project, it can be concluded that:

1. Professors in GLCA colleges can prepare high quality programed materials although it is a time consuming process.

2. Good, short, single topic programs can be successfully used as instructional devices in all three major areas of the curriculum. Students learn from them, faculty and students generally rate them positively. They provide a way of making college teaching more varied and flexible. They teach as well or better than other usual methods of instruction. Although the results of the evaluation of commercial programs were less clear and positive, it is likely that the same conclusion holds for high quality commercial programs.

3. Different programs succeed for different reasons and the variables accounting for success can be sorted out for each program.

4. Preparing programed materials holds promise as a significant procedure for analyzing and improving some aspects of teaching and possibly as an in-service education procedure.

5. The project demonstrated the feasibility and value of having an association of colleges rather than a single institution carrying out a project such as this one—preparing and evaluating programs, studying the broader effects of programing, and disseminating information about instructional matters.

APPENDICES

APPENDIX A
LIAISON COMMITTEE

A Liaison Committee was formed early in the life of the project. The Liaison Committee performed yeoman service to the project in keeping faculty members informed of the progress of the project and advising the director of currents of opinion and developments on the campus with respect to the project. The Liaison Committee met five times during the course of the project, three times in the first year and once in each of the two subsequent years. Members of the Liaison Committee were:

Albion College
Dr. Paul Carnell, Chairman—Department of Chemistry
2nd and 3rd years—Dr. Dean Dillery, Dept. of Biology

Antioch College
Dr. Robert MacDowell, Associate Professor of Mathematics
3rd year—Professor Richard Meislar, Dept. of Philosophy

Denison University
Dr. Irvin Wolf, Professor of Psychology

DePauw University
Dr. Clark Norton, former Director of Graduate Studies;
Asst. Dean of the University, Professor of Political Science
2nd year—Dr. Kenneth Wagoner, Chairman, Dept. of Psychology

Earlham College
Dr. Daniel Smith, Assistant Professor of Education,
Coordinator of Self-Instruction

Hope College
Dr. Ralph Perry, Professor of Romance Languages Department

Kalamazoo College
Dr. Walter W. Waring, Chairman—Department of English

Kenyon College
Dr. Bruce Haywood, Dean of the College

Oberlin College
Dr. Loche Van Atta, Associate Professor of Psychology

Ohio Wesleyan University
Dr. Francis Alter, Chairman—Department of Education
3rd year—Dr. Joseph Wetmore, Professor of Education

Wabash College
Dr. Paul Mielke, Associate Professor of Mathematics

College of Wooster
Dr. Donald G. Beane, Assistant Professor of Education
3rd year—Dr. Sam Cho, Department of Psychology

APPENDIX B

DESCRIPTION OF PROGRAMS PRODUCED ON THE PROJECT IN 1964 AND 1965

The following programs were produced in 1964:

TECHNICAL FILMS ON BASIC PRINTMAKING TECHNIQUES, Paul Arnold, Department of Art, Oberlin College, Oberlin, Ohio

General Objectives: To break down the basic techniques of intaglio printmaking into component steps, each of which is covered clearly and in detail in a loop film which can be projected easily by the student when he needs the information. The films eliminate the necessity for repeated individual explanations and demonstrations.

GERMAN VOCABULARY THROUGH COGNATES, Robert Brewster, Department of German, Earlham College, Richmond, Indiana

General Objectives: To provide the beginning student of German with an active vocabulary of 200 words, over-learned visually and aurally, and

To have the student learn inductively ten of the main consonantal relationships between English and German through these 200 word examples, and

To help the student recognize new German words on the basis of these consonantal laws.

POETRY, METHOD AND MEANING: A PROGRAM IN POETIC ANALYSIS AND CRITICISM, James W. Cook, Department of English, Albion College, Albion, Michigan

General Objectives: Student should use critical vocabulary when writing, thinking, or talking about poetry.

Student should identify figures of speech and thought when they occur in a poem.

Student should be able to analyze and specify the contribution of figures of speech and thought to a poem's meaning.

Student should be able to posit multi-level interpretations of a poem.

ANALYTIC GEOMETRY: THE LINE, Thomas A. Davis, Department of Mathematics, DePauw University, Greencastle, Indiana

General Objectives: This program is designed to be used in a college level course on analytic geometry and calculus or a text in calculus. Students taking these courses have a wide range of previous training. This program will allow each student to spend as much time on each topic as he needs, to learn the material he does not know.

A PROGRAM ON CRYSTAL STRUCTURE, Ansel M. Gooding, Department of Geology and Soil Science, Earlham College, Richmond, Indiana

A SELECTED INTRODUCTORY ORGANIC CHEMISTRY PROGRAM, Peter J. Hawkins, Department of Chemistry, Oberlin College, Oberlin, Ohio.

CONSTRUCTING THE UNIT CARD FILING IN THE LIBRARY

PUBLIC CATALOG AND SHELF LIST

CHOICE OF MAIN AND ADDED ENTRIES

CHOICE OF SUBJECT HEADINGS

CLASSIFICATION, J. McKee Elrod, Library, Ohio Wesleyan University, Delaware, Ohio.

General Objectives: To prepare library clerical and sub-professional personnel to perform a higher level of technical processing functions as listed in the titles of the programs; to allow the library school teacher to teach these clerical and sub-professional functions outside the regular classroom.

CAPITAL BUDGETING, METHODS OF RANKING PROJECT PROPOSED FOR INVESTMENT, Vant W. Kebker, Department of Economics, Ohio Wesleyan University, Delaware, Ohio

General Objectives: To help students understand why the method of discounting expected cash flows of income is better than other methods evaluating and ranking proposals that involve investment of capital.

A PROGRAM OF SELF INSTRUCTION IN SOCIAL ORGANIZATION, Richard Knudten, Department of Sociology, Newberry College, Newberry, South Carolina.

LIBRARY OF CONGRESS CARD ORDER ROUTINE, Peter Kidder, Library, Kenyon College, Gambier, Ohio

General Objectives: The program is designed to prepare people to do preliminary bibliographic searching in connection with ordering LC cards; order them; check them in, and do necessary follow-up work.

HUMAN NATURE, Clarence Leuba, Department of Psychology, Wright State University

General Objectives: To enable the student to answer certain specific questions regarding what human nature is and is not, and regarding the characteristics making up human nature.

THE SOIL: A PROGRAMED TEXT, W. M. Lotkowski, Department of Earth Sciences, Antioch College, Yellow Springs, Ohio

General Objectives: To enable a student to answer such questions as: What is soil and how is it formed? How do temperature, humidity, composition of underlying rock material, vegetation, topography, time, and land use affect soil? Of what use are particular soils, and how can they be used most effectively?

FORMAL STRUCTURE OF THE SHORT STORY, Kenneth B. Marshall, Department of English, Denison University, Granville, Ohio

General Objectives: To train students to perceive function, within a short piece of fiction, of certain formal elements of structure: plot, character, narrative technique and attitude (including irony and use of symbol).

PERSONNEL SELECTION: A SELF-INSTRUCTIONAL PROGRAM, F. S. McKenna, Dept. of Psychology, DePauw University, Greencastle, Ind.

General Objectives: To provide a self instructional and self contained unit on the fundamental concepts and techniques of personnel selection.

Upon completion of this program, the student would be expected to be able to read the professional literature in this field with understanding and to develop systematic personnel selection procedures.

THE LITERARY RELATIONSHIPS AMONG MATTHEW, MARK, AND LUKE, R. M. Montgomery, Department of Religion, Ohio Wesleyan University, Delaware, Ohio

General Objectives: Having completed the unit and given material selected from Matthew, Mark, and Luke, the student should be able to identify the evidence supporting the theory that (a) Matthew and Luke used Mark, and (b) Matthew and Luke did not depend upon each other but upon an unknown source in their material which does not come from Mark.

AN INTRODUCTION TO SYSTEMATIC ANALYSIS OF POLITICAL SCIENCE, Lois M. Pelekoudas, Department of Political Science, Antioch College, Yellow Springs, Ohio

General Objectives: To identify and to state a problem in political science, identify hypotheses and assumptions, to frame hypotheses, and to identify major approaches in works of political science.

THE LANGUAGE OF LOGIC, Morton Schagrin, Department of Physical Science, Denison University, Granville, Ohio

General Objectives: To prepare students with no background in modern logic with sufficient familiarity to read with comprehension recent studies in the philosophy of science and semantics which are written in this notation.

HEARING MUSIC WITH UNDERSTANDING, Paul Schwartz, Department of Music, Kenyon College, Gambier, Ohio

General Objectives: An introduction to elements of music through sight and sound; a text, consisting of 9 chapters, with tapes accompanying each chapter.

INTRODUCTION TO THEORY AND SUBJECT MATTER OF ECONOMICS, Fred S. Silander, Department of Economics, DePauw, University, Greencastle, Indiana

MUSIC: BEGINNING EAR-TRAINING, L. R. Smith, H. B. Ray, R. A. Hammar, Department of Music, Kalamazoo College, Kalamazoo, Michigan

General Objectives: To develop basic listening skills (Perception of intervals and rhythmic Patterns).

BIOCHEMISTRY FOR BIOLOGISTS, William K. Stephenson, Department of Biology, Earlham College, Richmond, Indiana

General Objectives: Students will attain the chemistry and biochemistry requisite for the first course in contemporary college biology.

PROGRAMED GERMAN READERS, Guy Stern, Department of German, University of Cincinnati, Cincinnati, Ohio.

STUDY HABITS, F. P. Van Eyl, Department of Psychology, Hope College, Holland, Michigan

General Objectives: To develop study habits that lead to a more successful way of studying textbooks.

PUBLIC SCHOOL FINANCE, J. N. Wetmore, Department of Education, Ohio Wesleyan University, Delaware, Ohio

General Objectives: To teach undergraduate students all aspects of public school finance—local, state and federal.

THE NATURE AND USES OF COLOR, Forbes Whiteside, Department of Art, Oberlin College, Oberlin, Ohio

General Objectives: To teach and help the student gain familiarity with the interactions between hue, value and intensity.

BIRD SONGS, James B. Cope, Department of Biology, Earlham College, Richmond, Indiana

General Objectives: To teach students bird songs with the use of audio and visual aids.

ORGANIZATION OF THE LIBRARY, Evan Farber, Library, Earlham College, Richmond, Indiana

General Objectives: To train sub-professional help in library organization and entries.

The following programs were produced in 1965:

A PROGRAM IN COMPOSITION, Fred L. Bergmann, Department of English, DePauw University, Greencastle, Indiana

General Objectives: To enable the student to recognize and to write effective paragraphs through recognition of the basic principles of unity, coherence, and emphasis.

FACT AND FORM: ELEMENTARY PRINCIPLES OF SENTENCE DESIGN, Owen Duston, Department of English, Wabash College, Crawfordsville, Indiana

General Objectives: To enable the student to use the resources of sentence structure to organize the facts of his experience.

A PROGRAMED INTRODUCTION TO SARTE'S ANALYSIS OF FREEDOM, Robert Fichter, Department of Religion, Ohio Wesleyan University, Delaware, Ohio

General Objectives: Find the rule which governs talk about Freedom, and Apply the rule to talk about Freedom.

PASO A PASO, A BASIC COURSE IN SPANISH THROUGH MEANING AND STRUCTURE, Renato J. Gonzales, Department of Spanish, Albion College, Albion, Michigan

General Objectives: To teach introductory Spanish, more specifically to train the student in the basic elements of Spanish by directly interacting with the languages without recourse to traditional grammar or translation skill.

ALTERNATIVE LOGICS, L. H. Hackstaff, Department of Philosophy, Wabash College, Crawfordsville, Indiana

General Objectives: To teach undergraduate students several alternative systems of propositional logic.

LABORATORY SUPPLEMENT FOR CHEMISTRY 11 AND 12, Alfred Henderson and Laurence Strong, Department of Chemistry, Earlham Col-

lege, Richmond, Indiana

General Objectives: To introduce students to an experimental study of interaction among the compounds of a mixture. The students see how continuous variation experiments can provide quantitative data suitable for establishing chemical equations. He also learns to test the humidity of proposed chemical equation by designing his own continuous variation experiment.

MUSICAL RHYTHM (METER, PARTS A, B, AND C), Leonard Holvik, Department of Music, Earlham College, Richmond, Indiana

General Objectives: To bring students to a common level for discussion of rhythm and related matters in the classroom—to give them command of the verbal material and concepts and of the actual musical phenomena concerned.

THE ECOLOGY OF PUBLIC ADMINISTRATION, William L. Morrow, Department of Political Science, DePauw University, Greencastle, Indiana

General Objectives: To help the beginning student of public administration attain a realistic perspective of the nature of administration in general.

INTRODUCTION TO MODERN PHYSICS, B. R. Russell, Department of Physics, College of Wooster, Wooster, Ohio

General Objectives: To present certain key topics in modern physics in a form suitable for use as supplementary material in a beginning college physics course.

A PROGRAMED REFERENCE GRAMMAR FOR ELEMENTARY SPOKEN AND WRITTEN FRENCH, Richard R. Strawn, Department of Romance Languages, Wabash College, Crawfordsville, Indiana

General Objectives: To state the grammar rules for each topic treated and to apply the rules correctly, on paper, to new instances.

CRYSTALS: AN INTRODUCTION—A PROGRAMED LABORATORY AND INDEPENDENT STUDY UNIT, John F. White, Department of Earth Sciences, Antioch College, Yellow Springs, Ohio

General Objectives: To provide a stimulating and efficient programed study unit on crystals for introductory courses;
To present the material so it can be useful for both science and non-science students;
To provide for the integration of material that is ordinarily presented separately through lectures, text, and laboratory.

ELECTROPHYSIOLOGY OF NERVOUS TISSUE, Francis W. Yow, Department of Biology, Kenyon College, Gambier, Ohio

General Objectives: Use and theory of Stimulator—Oscilloscope Complex and Interpretation of Oscilloscope Image with respect to transmition of nerve impulse.

APPENDIX C

FACULTY MEMBERS WHO EVALUATED GLCA PROGRAMS

The twenty-four studies included in the evaluation of the five GLCA-produced programs were conducted on the campuses of nine colleges, eight of which were Great Lakes colleges. Twenty-six professors participated in the evaluation of the programs. They were the following:

Daniel Anderson
Philosophy Department
Ohio Wesleyan University

Thomas Boyle
English Department
Albion College

Philip Church
English Department
Kenyon College

Robert Johnson
English Department
DePauw University

Mrs. Sue McNaghton
Department of Government
Denison University

Roy Morey
Department of Government
Denison University

Morton Schagrin
Department of History
and Sciences
Denison University

William Richard Stegner
Religion Department
Illinois Wesleyan University

Jerry Stone
Religion Department
Illinois Wesleyan University

Brad Angell
Philosophy Department
Ohio Wesleyan University

T. R. Burkett
English Department
Denison University

Robert DeHaan
Education Department
Hope College

William Judd
English Department
Ohio Wesleyan University

Ray Mizer
English Department
DePauw University

Wendall Patton
Zoology Department
Ohio Wesleyan University

Lee Scott
Philosophy and Religion
Department
Denison University

William Stephenson
Biology Department
Earlham College

Jerome Tovo
Philosophy Department
College of Wooster

Phillip Van Eyl
Psychology Department
Hope College

Charles Weis
English Department
Ohio Wesleyan University

Louis Wilcox
Biology Department
Earlham College

Fred Wirt
Department of Government
Denison University

Melvin Vulgamore
Religion Department
Ohio Wesleyan University

William Westbrook
Economics Department
Denison University

Vannie Wilson
Biology Department
Denison University

Frank Yow
Biology Department
Kenyon College

APPENDIX D

Summary of Results of Analysis of Variance by Program and Design

	Poetry	Logic	Biochemistry	Religion	Pol. Science
Design #1	Mizer-Johnson Lng *** P vs. L[1] Church Lng *** P = L Judd-Weis Lng ** P = L	Anderson Lng *** P = T Angell Lng *** P = T Van Eyl Lng *** P = T	Stephenson-Wilcox Lng *** P > L ** P > T ** Yow Lng *** P > L ***	Vulgamore Lng *** P > L * Stegner Lng *** P = L	Wirt Lng *** P = L
Design #2	Burkett Lng *** P + D = P + L	DeHaan Lng *** P + D = P + L	Stephenson-Wilcox Lng *** P + D = P + L = P + D (mixed)	Scott Lng *** P + D vs P + L[1]	McNaghten Lng *** P + D = P + L
Design #3	Boyle Lng *** P + L = L + P	Schagrin Lng *** P + L = L + P	Patton Lng *** P + L = L + P	Stegner-Stone Lng *** P + L = L + P	Morey Lng *** P + L = L + P
Design #4		Tovo Lng *** P = L	Wilson Lng *** P = L		Westbrook Lng *** V = NV

Key: Lng—Learning as measured by differences between pre and post test scores

P—Programed materials
L—Lectures
T—Text materials
D—Discussion
V—Volunteers
NV—Non-volunteers

} Eg., P > L means that program was superior to lecture.

=—No statistically significant differences

*—P < .05
**—P < .01
***—P < .001

P, refers to the probability of the obtained results having occured by chance; < .05 means that the probability is less than 5 in 100; <.01, less than 1 in 100; <.001, less than 1 in 1000.

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1 data not conclusive since groups not comparable due to significant differences in means of pre-test scores.

APPENDIX E

Variance Accounted for by Variables used in Computing Multiple R's

	Program				
	Poetry	Logic	Bio-Chem.	Religion	Pol. Sci.
Percent of Variance Accounted for by Math, Verbal, and Pretest Scores	15.98	27.07	1.35	13.64	18.89
Percent of Variance Accounted for by Remaining Significant Variables	15.35	13.48	10.80	19.83	12.83
Total percent of Variance Accounted for by Multiple R	31.33	40.55	12.15	33.47	31.72